Report for 2001CA3901B: Landscape Level Controls on Nitrate-Nitrogen in Forested and Chaparral Catchments of Southern California

- Conference Proceedings:
  - Meixner, T, M., E. Fenn, and M. A. Poth, Nitrate in Polluted Mountainous Catchments With Mediterranean Climates In Optimizing Nitrogen Management in Food and Energy Production and Environmental Protection, Proceedings of the 2nd International Nitrogen Conference on Science and Policy. The Scientific World, 1, DOI 10.1100/tsw.2001.324.
- Other Publications:
  - Meixner T., E. B. Allen, K Tonnessen, M. Fenn, and M. Poth, Atmospheric Nitrogen Deposition: Implications for Park Managers of Western U.S. Parks, Park Science, 21(2), p. 30-33, 2002.
  - Meixner, T., and M. E. Fenn, Riparian Areas as Biogeochemical Filters, Mediterranean Climates and the Telescoping Ecosystem, A Cross-Cultural Perspective on Current Problems in Ecosystem and Natural Resources Management: An International Course on Issues Related to Ecosystem Management. Ed. J. Tenhunen, University of Bayreuth, Bayreuth, Germany, 2002.

Report Follows:

Landscape Level Controls on Nitrate-Nitrogen in Forested an Catchments of Southern California

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Project Summary

The mountains of Southern California receive amongst the highest rates of anthropogenic N deposition in the world (~40 kg ha^{-1} yr^{-1}) and as a result stream water NO_3^- concentrations in smog-impacted summer-dry montane ecosystems in the Los Angeles air basin are the highest for natural catchments in North America. The localized nutrient enrichment in the mountains surrounding the Los Angeles metropolitan area may be the precedent for the future of forests and other ecosystem types near urbanizing areas in the western United States, as emissions of NO_x and NH_3 increase with urban expansion.

Terrestrial ecosystems with semiarid climates have limited capacity to process and retain chronic inputs of N. Available data indicates that stream flow from watersheds under heavier influences of the smog generated in Los Angeles have higher NO_3^- concentrations than those that are farther away. However, the NO_3^- concentrations of stream flows in a watershed are extremely variable. The stream flow through the Devil Canyon catchment in the western San Bernardino Mountains, 100 km east of Los Angeles is a case in point. Although aerial N deposition should be similar throughout the Devil Canyon watershed, NO_3^- concentrations vary by several orders of magnitude among the sampling sites. The spatially varied distribution of NO_3^- in stream flow provides a unique opportunity to investigate the landscape scale dynamics of biogeochemical and hydrologic processes that exert the greatest control on NO_3^- export from semi-arid forested catchments with elevated N deposition. We conducted detailed water quality sampling at eight streams in the Devil Canyon watershed. So far we have been able to reach several conclusions from our observations.

1. The NO_3^- and dissolved organic carbon (DOC) concentrations of water increase as the stream flow increases. In a couple of the smaller streams, there is a noticeable first "flush" of NO_3^- at the onset of the winter rainy season and then it is followed by a drop in NO_3^- concentrations as stream flow continues at a level higher than the base flows of the summer and fall. The increase in NO_3^- with stream flow in the larger streams at the commencement of the rainy season may also indicate a flushing process. However, we do not observe a decrease in NO_3^- concentrations as the rainy season progresses indicating that a flushing process is not so apparently responsible for the increases of NO_3^- in the larger streams.

2. The strong correlation of DOC and NO_3^- concentrations may indicate a denitrification control on NO_3^- input to streams. The concept of a denitrification control on stream nitrate and DOC concentrations is further bolstered by results of longitudinal surveys and mass balance analyses that indicating plant uptake and denitrification in the riparian zone, rather than a mass dilution process, are responsible for the decline in NO_3^- concentrations.

3. Perennial streams have high NO_3^- concentrations while ephemeral streams do not. This difference points to groundwater as the source of the high levels of NO_3^- we observe in the perennial streams. Geochemical mixture modeling for the watershed indicates that the perennial streams of the watershed are dominated by groundwater seeping to the surface in all seasons. The mixture modeling also indicate a disconnect between the streams of the watershed and the surrounding landscape since stream composition bears little resemblance to soil water from zero-tension lysimeters in the watershed. Furthermore, the evidence indicates a decoupling of the impact of N deposition on terrestrial and aquatic systems in Mediterranean climates. The primary reason for the decoupling involves the asynchrony between when atmospheric deposition occurs (summer), the time period of maximum soil NO_3^- availability and leaching (winter), and the time of maximum plant N demand (spring).

Our results have important implications for wildlife and water resources management agencies as they respond to the adverse impacts of atmospheric N deposition on water quality. For wildlife managers the findings indicate that the streams with the best habitat, those with large and consistent flows, are those most likely to be impacted by the effects of N deposition. For water resource managers the results indicate that the times when they are most likely to get water for recharge or for filling reservoirs, periods of high flow, are also the periods which are expected to have the highest nitrate concentrations indicating less of a chance to use waters draining deposition impacted watersheds to dilute groundwater impacted by historic agricultural groundwater contamination.

Publications

Meixner, T, M., E. Fenn, and M. A. Poth, Nitrate in Polluted Mountainous Catchments With Mediterranean Climates In Optimizing Nitrogen Management in Food and Energy Production and Environmental Protection, *Proceedings of the 2nd International Nitrogen Conference on Science and Policy. The Scientific World,* 1, DOI 10.1100/tsw.2001.324.
Meixner T., E. B. Allen, K Tonnessen, M. Fenn, and M. Poth, Atmospheric Nitrogen Deposition: Implications for Park Managers of Western U.S. Parks, *Park Science*, 21(2), p. 30-33, 2002.

Meixner, T., and M. E. Fenn, Riparian Areas as Biogeochemical Filters, Mediterranean Climates and the Telescoping Ecosystem, A Cross-Cultural Perspective on Current Problems in Ecosystem and Natural Resources Management: An International Course on Issues Related to Ecosystem Management. Ed. J. Tenhunen, University of Bayreuth, Bayreuth, Germany, 2002.

Professional Presentations

J. McGovern, The Role of Hyporheic and Riparian Processes on Controlling Nitrogen Flux in a Mediterranean-Type Montane Environment, Chemical and Environmental Engineering Annual Graduate Student Conference, Riverside, California, August 28, 2001.

T. Meixner, Nitrate in Polluted Mountainous Catchments With Mediterranean Climates Abbreviated title- Mediterranean Climate Nitrate, In Optimizing Nitrogen Management in Food and Energy Production and Environmental Protection: Proceedings of the 2nd International Nitrogen Conference on Science and Policy, Potomac, Maryland, October 17, 2001.

T. Meixner, Aquatic Impacts of Atmospheric Deposition in a Mediterranean Climate: The Asynchrony Hypothesis, CEA-CREST Annual Conference, Pasadena, California, May 8, 2002.

T. Meixner, Riparian Areas as Biogeochemical Filters, Mediterranean Climates and the Telescoping Ecosystem, A Cross-Cultural Perspective on Current Problems in Ecosystem and Natural Resources Management: An International Course on Issues Related to Ecosystem Management, Berchtesgaden, Germany, May 23, 2002.

Student Training

Jeff McGovern, MS student, Chemical and Environmental Engineering, UC Riverside.
Bridgette Valeron, Undergraduate, Environmental Sciences, UC Riverside.
Julie Quinn, Undergraduate, Environmental Sciences, UC Riverside.
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